

Mathematical Simulation of Small Log Ripped by Slasher Saw

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Abstract Using the ellips-paraboloid log model with the four practical measurable parameters, the exact volume of all the uncut-boards and clabs cut by the multi-bit ripping edge has been measured. The kerf lossing and recovery have been accurately calculated. By the theories, a quite simple NC detecting system of the multi-bit ripping edge will be designed, which makes the numerical control of processing timber industry of small logs realizable.

Key words: Mathemtical Simulation, Small log, Wood processing

With the small sawlog widespread used, the uncut-boards and slabs are cut by the multi-bit ripping edge in the timber industry. After sawing ripped, the unedged board accurately volume is:

$$v_{1y} = \frac{\pi}{8} D_{a1} D_{b1} L \left(1 + \frac{1}{q^2} \right) D_{my} \quad (1)$$

formulate:

$$\begin{aligned} D_{my} = & \frac{1}{3\pi(1-q^4)} [3(\arcsin q_{4y} - \arcsin q_{3y}) \\ & - 3q^4 \left(\arcsin \frac{q_{4y}}{q} - \arcsin \frac{q_{3y}}{q} \right) \\ & + q_{4y}(5-2q_{4y}^2)\sqrt{1-q_{4y}^2} \\ & - q_{3y}(5-2q_{3y}^2)\sqrt{1-q_{3y}^2} \\ & - q_{4y}(5q^2-2q_{4y}^2)\sqrt{q^2-q_{4y}^2} \\ & + q_{3y}(5q^2-2q_{3y}^2)\sqrt{q^2-q_{3y}^2}] \end{aligned} \quad (2)$$

among: $q = \frac{D_{a1}}{D_{a2}} \quad (3)$

$$q_{3y} = \frac{2(y_1 - S)}{D_{a2}} \quad (4)$$

$$q_{4y} = \frac{2y_1}{D_{a2}} \quad (5)$$

Another parameters are definite by a drawing, the approximate volume formulate of unedged board is:

$$v_{1y} = \frac{\pi}{4} D_{a1} D_{b1} L D_q D_{my} \quad (6)$$

formulate:

$$\begin{aligned} D_{my} = & \frac{q_{2y} - q_{1y}}{2\pi(1+q^2)} [2(3+q^2) + \\ & (1+3q^2)(q_{2y}^2 + q_{1y}q_{2y} + q_{1y}^2)] \end{aligned} \quad (7)$$

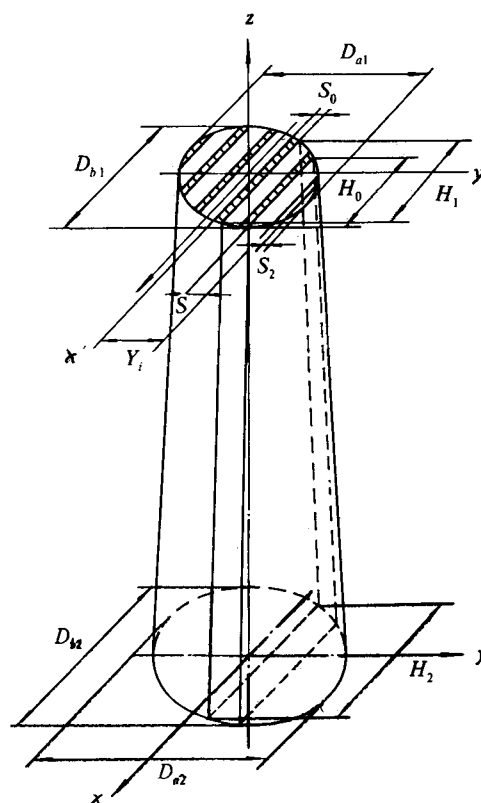


Figure 1. The unedged board parameters drawing

The parameters table:

D_{a1} ---D. of smaller long end;
 D_{b1} ---D. of smaller short end;
 D_{a2} ---D. of larger long end;
 D_{b2} ---D. of larger short end;
 S_0 ---kerf thick;
 S ---unedged board thick;
 S_2 ---slab thick of smaller end;
 H_0 ---slab short wide of smaller end;
 H_1 ---slab long wide of smaller end;
 H_2 ---slab long wide of larger end;
 y_1 ---location dimension of converting;

x, y, z ---coordinate;

x', y' ---coordinates of smaller end.

among:

$$D_q = 1 + \frac{1 - q^2}{2q^2} \quad (8)$$

$$q_{1y} = \frac{D_{a2} - 2S}{D_{a2}} \quad (9)$$

$$q_{2y} = \frac{S}{D_{a2}} \quad (10)$$

If it is a pith unedged board, the approximate volume formulate is:

$$v_{1y} = \frac{\pi}{4} D_{a1} D_{b1} L D_q D_{sy} \quad (11)$$

formulate:

$$D_{sy} = \frac{2}{\pi} \left[\arcsin q_{2y} + q_3 q_{2y} \sqrt{1 - q_{2y}^2} \right] \quad (12)$$

$$q_3 = \frac{2}{1 + q^2} \quad (13)$$

when sawing small sawlog, the side board is the slab of end flat, its volume formulate is:

$$v_{4y} = \frac{\pi}{4} D_{a1} D_{b1} L D_q D_{py} \quad (14)$$

formulate:

$$D_{py} = \frac{1}{\pi} \left[\arcsin q - \arcsin q_{iy} + \frac{\pi - 2 \arcsin q}{2(1 - q^4)} + \frac{2(q\sqrt{1 - q^2} - q_{iy}\sqrt{1 - q_{iy}^2})}{1 + q^2} - \frac{q(5 - 2q^2)\sqrt{1 - q^2}}{3(1 - q^4)} \right] \quad (15)$$

If the slab is a point end, its volume formulate is:

$$v_{3y} = \frac{\pi}{4} D_{a1} D_{b1} L D_q D_{oy} \quad (16)$$

formulate:

$$D_{oy} = \frac{1}{3\pi(1 - q^4)} \left[3\left(\frac{\pi}{2} - \arcsin q_{1y}\right) - q_{1y}(5 - 2q_{2y}^2)\sqrt{1 - q_{1y}^2} \right] \quad (17)$$

If the large slab is cut, a small board will be sawed with a point end, its volume formulate is:

$$v_{2y} = \frac{\pi}{4} D_{a1} D_{b1} L D_q D_{ny} \quad (18)$$

formulate:

$$D_{ny} = \frac{1}{3\pi(1 - q^4)} \left[3(\arcsin q_{2y} - \arcsin q_{1y}) + q_{2y}(5 - 2q_{1y}^2)\sqrt{1 - q_{2y}^2} - q_{1y}(5 - 2q_{1y}^2)\sqrt{1 - q_{1y}^2} \right] \quad (19)$$

In this paper, the ellips-paraboloid log model with the four practical measurable parameters are used. It is measured that the exact volume of all the uncut-boards the clabs with flat or point end and the small board. The kerf volume is a unedged board or a small board ones. The loss of the saw kerf and recovery was accurately calculated. By the theories, a quite simple NC detecting system of the multi-bit ripping edger will be designed, which make the numerical control for the matching of a small log timber industry realizable.

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